Photoelectrochemical properties of full composition $In_xGa_{1-x}N$/Si photoanodes

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Recently $In_xGa_{1-x}N$ (x=0-1) thin films and nanostructures have attracted considerable interest in the field of solar assisted water splitting.[1] As a standalone photoelectrode it is very appealing due to its direct, tunable bandgap covering nearly the entire solar spectrum (Fig. 1a), high absorption coefficient and mobility, along with near-perfect band-edge potentials. Moreover, because of the special bands alignment it can be grown on p-Si photocathode and exhibit vertical conductivity without complex tunnel junction.[2] These facts open a possibility to achieve high efficiency, relatively cheap InGaN/Si-based two-photon tandem devices for water splitting.

Previously, we have demonstrated that high quality, compact, and chemically homogeneous $In_xGa_{1-x}N$ layers can be grown, over entire compositional range, directly on Si(111) by plasma-assisted molecular beam epitaxy.[3] The performance of $In_{\sim 0.4}Ga_{0.6}N$-based photoanodes, the most important for tandem devices, was also evaluated.[4,5]

In this work we study the photoelectrochemical properties of $In_xGa_{1-x}N$/Si thin films over entire alloy composition range. A correlation between band gap and onset potential for compositions of x=0-0.45 is established (Fig. 1b). For higher x values, $In_xGa_{1-x}N$ suffers from a high unintentional n-type doping, which results in metal-like behavior. The use of magnetron sputtered Ni- and NiO-based catalysts is discussed.

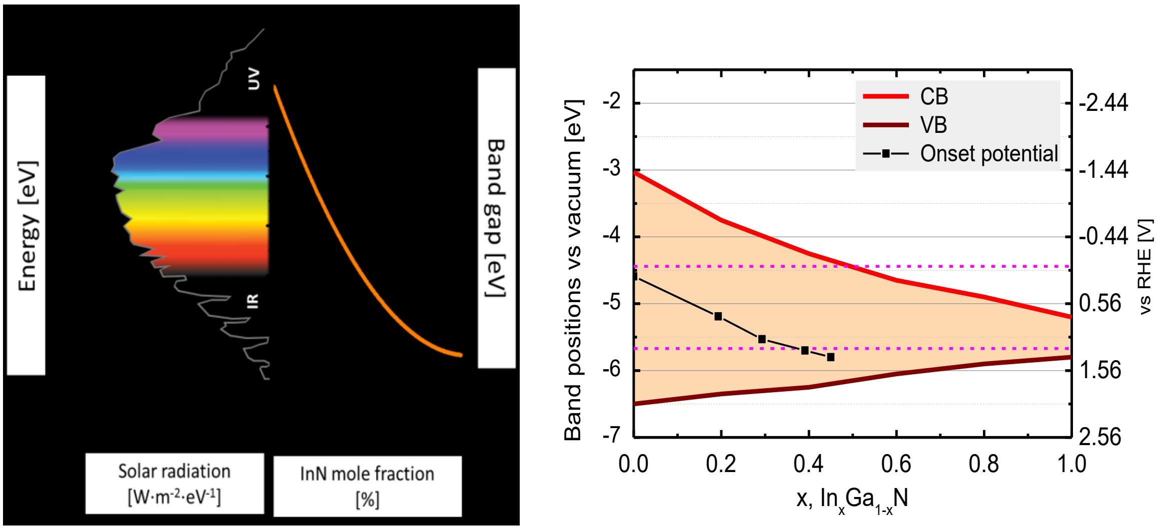

Fig. 1. (a) Solar spectrum overlap with $In_xGa_{1-x}N$ band gap. (b) Onset potential of $In_xGa_{1-x}N$ film photoanodes as a function of the alloy composition.

References

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